Supplementary Material

Full Instructions for Experiment 1

Before beginning the task participants read the following instructions:

> You will perform a gambling task where you will be asked to make selections from one of four options. After each selection you will gain a certain number of points. Your objective is to gain as many points as possible. You will have a specific goal to earn a certain number of points by the end of the task. When you begin the task your goal will be listed on the screen. Try your best to earn as many points as possible.
>
> Four decks will appear on the screen. You will use the 'W', 'Z', 'P', and '?/' keys to pick from these decks.
> Press the 'W' key to pick from the deck on the top left.
> Press the 'Z' key to pick from the deck on the bottom left.
> Press the 'P' key to pick from the deck on the top right.
> Press the '?/' key to pick from the deck on the bottom right.
> You will receive between 1 and 10 points each time you draw a card. Your goal is to earn at least 550 points by the end of the task.

Full Instructions for Experiment 2

Before beginning the task participants read the following instructions:

> Welcome! It is the year 2031 and NASA has finally set foot on Mars. While Mars has less oxygen in its atmosphere than Earth, NASA scientists have discovered that there is indeed some oxygen. They are developing systems to optimally extract it so that our astronauts can survive while plant life develops to sustain humans.
>
> NASA has recruited you to test two new oxygen extraction systems to determine which system works best in the Martian atomosphere!
>
> You will repeatedly extract oxygen using one of the two systems. A narrow tank on the right will indicate how much oxygen the system extracted during the current test. This oxygen will be transferred to a larger tank. NASA needs you to fill up the large tank to a minimum level so that it can ensure the survival of the astronauts on the planet for a sustained period of time.
>
> You goal is to extract oxygen using the system that leads to the most oxygen collected over the long term. Press the 'Z' button to use the red system, and the '?/' button to use the blue system. A line near the top of the large tank will indicate the minimum amount you need to extract.
>
> Do your best! The success of NASA's space mission is in your hands!
>
> Press any key to begin

Neuropsychological Testing Data for Older Adults

Methods

Older adults were given a series of standardized neuropsychological tests. The battery of tests was designed to assess general intellectual ability across three functional realms: *attention* (WAIS-III Digit Span, Weschler, 1997; WAIS-III Letter-Number Sequence, Weschler, 1997; WAIS-III Arithmetic, Weschler, 1997; WAIS-III working memory, Weschler, 1997), *executive functioning* (Trail Making Test A&B (TMT), Lezak, 1995; Stroop Color-Word Test: Stroop, 1935; FAS; Wisconsin Card Sorting Task (WCST): Heaton, 1981), and *memory* (Wechsler Memory Scale Third Edition (WMS-III) subtests: Weschler, 1997; California Verbal Learning Test (CVLT): Delis, 1987). The tests were administered in a single two hour session, in the same basic order to all subjects. The delay period of these tests was kept constant, and was comprised of other tests not requiring any long term memory storage. The testing order was: CVLT, WAIS-III Arithmetic subtest, WAIS-III Vocabulary subtest, CVLT delayed recall, WMS-III Logical Memory subtest, Stroop, TMT A&B, WAIS-III Similarities subtest, WAIS-III Digit Span subtest, WMS-III Logical Memory delayed-recall, WMS-III Visual Reproduction subtest, WAIS-III Letter/Numbering Sequencing subtest, WCST computerized version, WMS-III Visual Reproduction delayed-recall.

The standard, age appropriate, published norms were used to calculate normative scores for each subject. Table 1 shows the means, standard deviations and ranges of standardized z-scores on each test for older adult participants in the study. For all of the WAIS subtests, the percentile was calculated according to testing instructions, and this score was then converted to a standardized z-score. For the Stroop, CVLT, and WCST standardized T-scores were calculated according to testing directions, and this score was then converted to a standardized z-score. Finally, for the TMT and COWA standard z-scores were calculated according to the testing instructions. Subjects were excluded from participation if they consistently scored two standard deviations below the standardized mean on neuropsychological tests in the same functional realm. The neuropsychological testing session was held well-before the experimental session, and only participants who were within normal ranges were asked to participate in the experiment.

Relationship Between Neuropsychological Test Scores and Task Performance

While the relationship between each older adult participant's scores on the neuropsychological tests and their performance in the decision-making task is beyond the scope of this paper, we examined correlations between scores from each neuropsychological test and points earned during each experiment. None of the neuropsychological measures were associated with performance for Experiment 1. For Experiment 2, we observed significant correlations between points earned and error scores on the WCST (errors ($r=.29$, $p<.05$), perseverative errors ($r=.32$, $p=.32$)). The errors measure on the WCST accounts for total incorrect answers on the WCST, and the perseverative errors measure from the Wisconsin Card Sorting Task (WCST) indicates the number of times a participant goes back to an old rule after the rule has changed. The WCST has been shown to activate the dorsolateral prefrontal cortex to store earlier events in working memory and the mid-ventrolateral prefrontal cortex to signal the need for a mental shift in response to a new set (Monchi et al., 2001).

Thus, while this analysis is exploratory, the results are consistent with the view that performance on the choice-dependent tasks in Experiment 2 involved frontally mediated, model-based learning of the choice-dependent nature of the reward structure.

Table 1

Neuropsychological Test	Mean (SD)	Range
Digit Span	0.93 (1.0)	-0.6 - 2.5
Character Sequence	0.99 (1.0)	-1.7 - 2.5
WAIS-III Arithmetic	0.94 (0.84)	-1.0 - 2.5
Wais WM	1.02 (1.1)	-0.9 - 3
Trails A	-0.42 (0.57)	-1.4 - 0.86
Trails B	-0.66 (0.47)	-1.23 - 0.83
Stroop Interference	0.51 (0.83)	-0.8 - 3
FAS	0.37 (0.81)	-0.91 - 2.40
WCST Categories	0.58 (0.90)	-2.1 - 2.0
WCST Errors	0.18 (1.4)	-2.3 - 2.5
WCST perseveration	0.26 (1.1)	-1.9 - 2.5
CVLT Immediate Recall	0.94 (0.89)	-1 - 2
CVLT Delayed Recall	0.78 (0.67)	-0.5 - 2
WMS-III Immediate Recall	0.84 (0.91)	-1 - 2.5
WMS-III Delayed Recall	1.4 (0.58)	0.3 - 2.5
Visual Reproduction Immediate	0.14 (1.0)	-1.3 - 1.7
Visual Reproduction Delay	0.84 (1.1)	-1.7 - 2.5

Table 2

Neuropsychological Test	Mean (SD)	Range
Digit Span	0.77 (0.93)	-1.30 - 2.50
Character Sequence	0.69 (0.95)	-1.70 - 2.50
WAIS-III Arithmetic	0.97 (0.78)	-1.00 - 2.50
Wais WM	0.84 (0.93)	-1.30 - 2.90
Trails A	-0.63 (0.66)	-1.63 - 1.31
Trails B	-0.46 (0.64)	-1.39 - 1.32
Stroop Interference	0.44 (0.79)	-1.40 - 3.00
FAS	0.27 (0.92)	-2.56 - 2.64
WCST Categories	0.15 (1.28)	-2.72 - 2.03
WCST Errors	0.14 (0.92)	-1.90 - 2.50
WCST perseveration	0.26 (0.79)	-1.90 - 2.50
CVLT Immediate Recall	0.68 (0.86)	-1.00 - 2.50
CVLT Delayed Recall	0.68 (0.82)	-1.00 - 2.50
WMS-III Immediate Recall	1.13 (0.85)	-1.00 - 2.50
WMS-III Delayed Recall	1.28 (0.96)	-1.00 - 2.50
Visual Reproduction Immediate	0.75 (1.17)	-1.30 - 2.50
Visual Reproduction Delay	0.92 (1.11)	-1.70 - 2.50

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